بسم الله الرحمن الرحيم

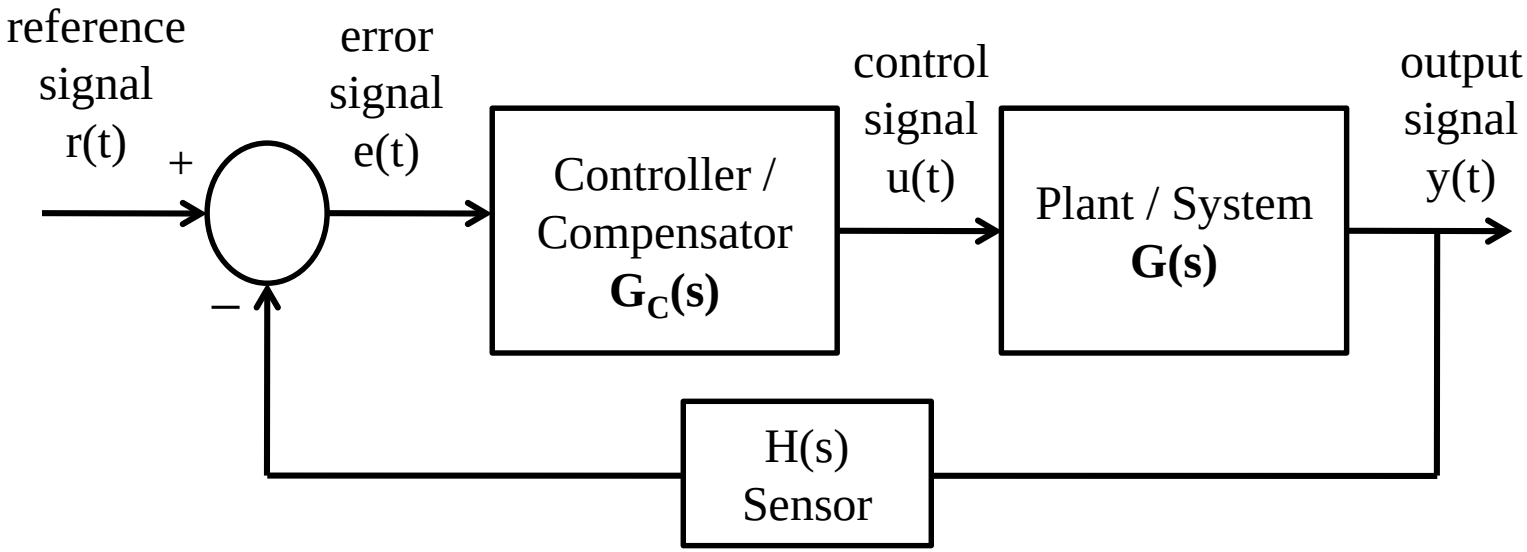
PLC Course

مقرر الحاكمات المنطقية البرمجة

Lec 1

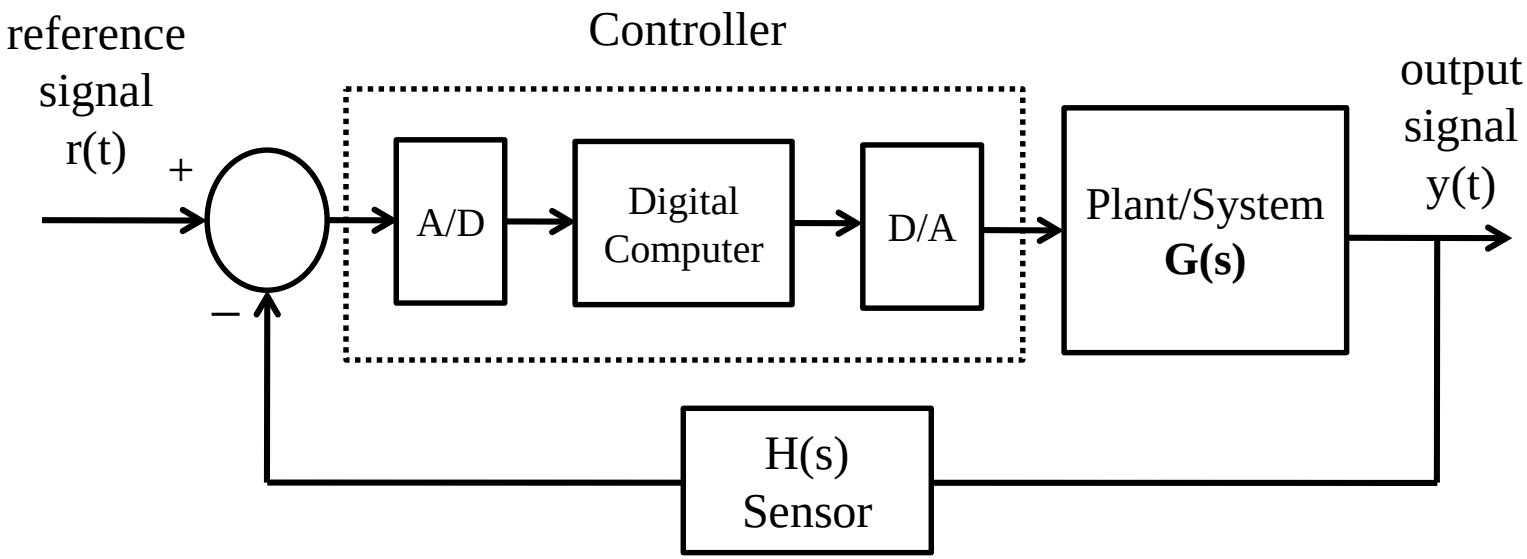
16/2/2016

Common Structure of Controller-Plant



A Common Structure of continuous-time Controller-Plant

Common Structure of Controller-Plant



A Common Structure of discrete-time Controller-Plant

Common Classification of Controllers

Controllers can be classify to :

1. Classical (or traditional) Controllers
2. Modern Controllers
3. Computational Intelligence Controllers
4. ON-OFF Controllers (sequence control) or two position controllers

1- Classical / traditional Controllers

- PI Controller (improve the steady-state error)
- PD Controller (speed up the system response and reduce the system over shot)
- PID Controller
- Phase Lead Controller (As PD)
- Phase Lag Controller (As PI)
- Phase Lead-Lag Controller (As PID)

2- Modern Controllers

- State Feedback Control (Pole placement Design)

$$u(t) = -K x(t)$$

- State Estimator (observer) Design

3- Computational Intelligence Controllers

Controllers that used the following Fields :

1. Fuzzy Logic (FL) / Fuzzy Control (FC)
2. Neural Networks (NN)
3. Adaptive Neuro Fuzzy Inference System or,

   Adaptive Network-based Fuzzy Inference System or,

   ANFIS.

3- Computational Intelligence Controllers

4. Evolutionary Computation:

Heuristic Algorithms Based on the principles of Darwinian evolution observed in nature. Example of these algorithms:

- genetic algorithm (GA)
- Differential Evolution Algorithm (DE)
- Particle swarm optimization (PSO)
- Fish Swarm Algorithm (FSA)
- Ant Colony Optimization Algorithm (ACO)
- Artificial Bee Colony Algorithm (ABC)
- Shuffled frog-leaping algorithm (SFLA)

4- ON-OFF Controllers (Sequence Control)

Sometimes, the control element has only two position either it is fully closed or fully open (1 or 0) (energized or de energized). This control element does not operate at any intermediate position, i.e. partly open or partly closed position. This type of controllers is known as on-off controllers or two position controllers.

As an Examples of these controllers:

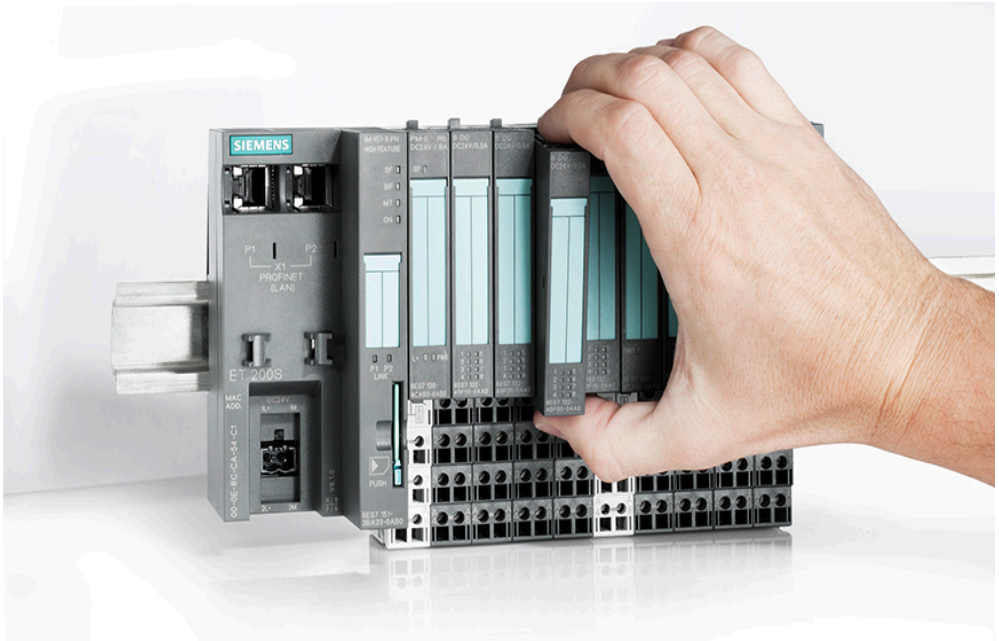
- Programmable Logic Controller (PLC)
- Microcontrollers

What Is A Programmable Logic Controller (PLC)?

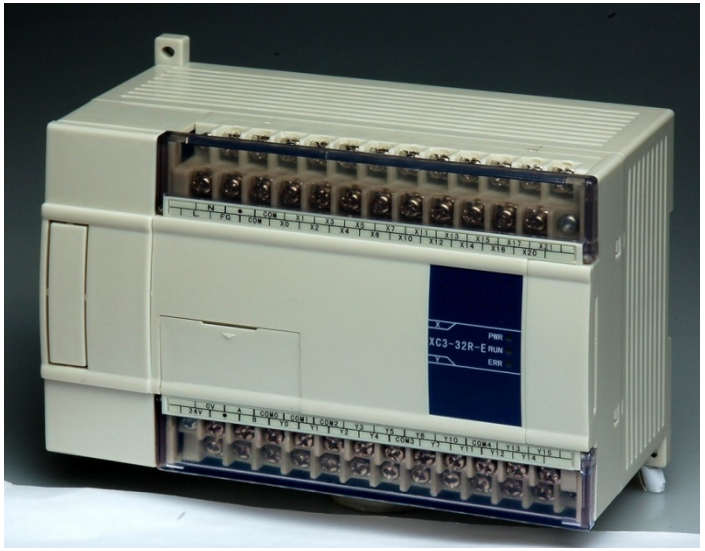
- A programmable logic controller (**PLC**) is an industrial computer control system that continuously monitors the state of input devices and makes logic-based decisions based upon a custom program to control the state of output devices.


XC3-32R-E
PWR
RUN
ERR

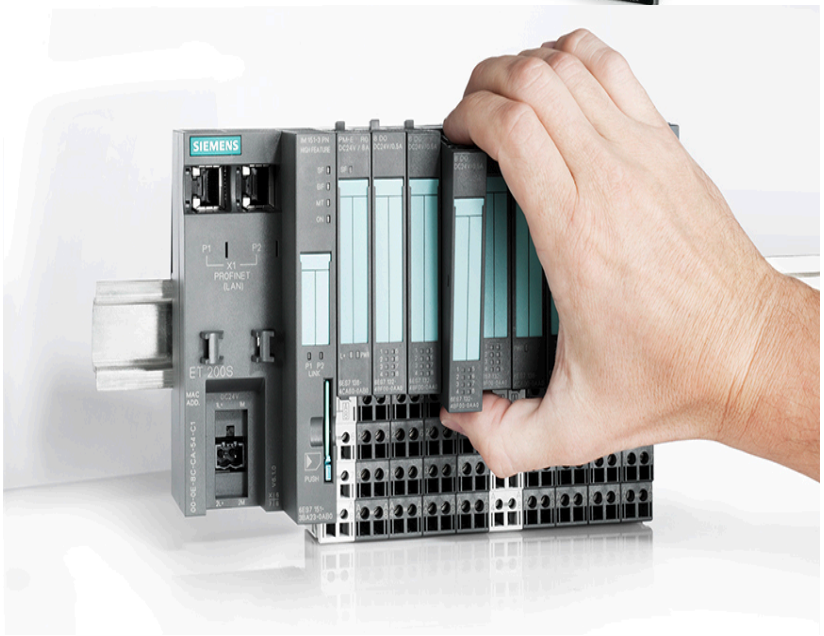

Direct205
LOGIC
Koyo
H2-DM1E
D2-08ND3
F2-02DAS-1
H2-CTRIO2
D2-04BDC1-1 12/24V


SIEMENS
ET 200S
PROFINET
(LAN)

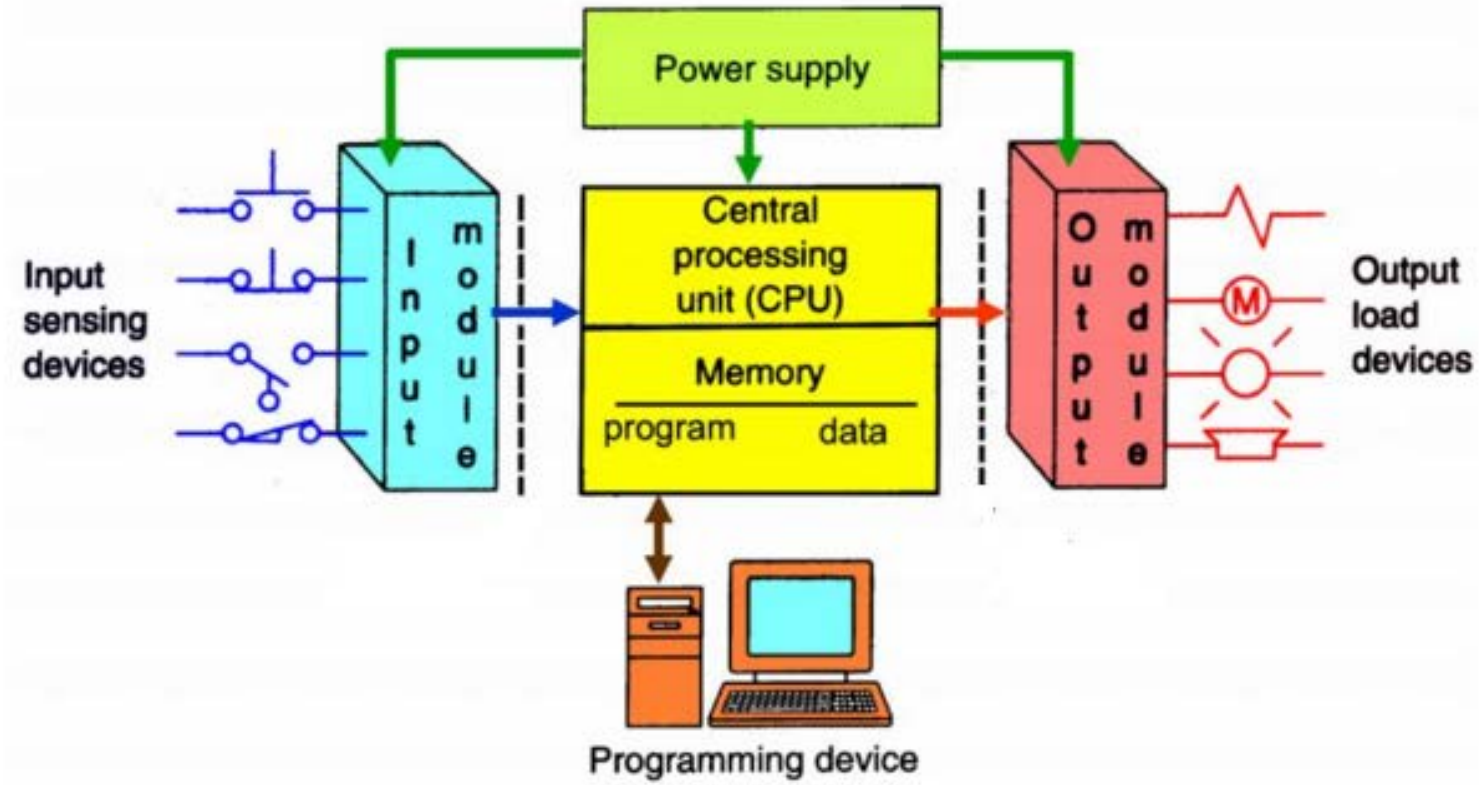
Box Type



Modular or Rack Type



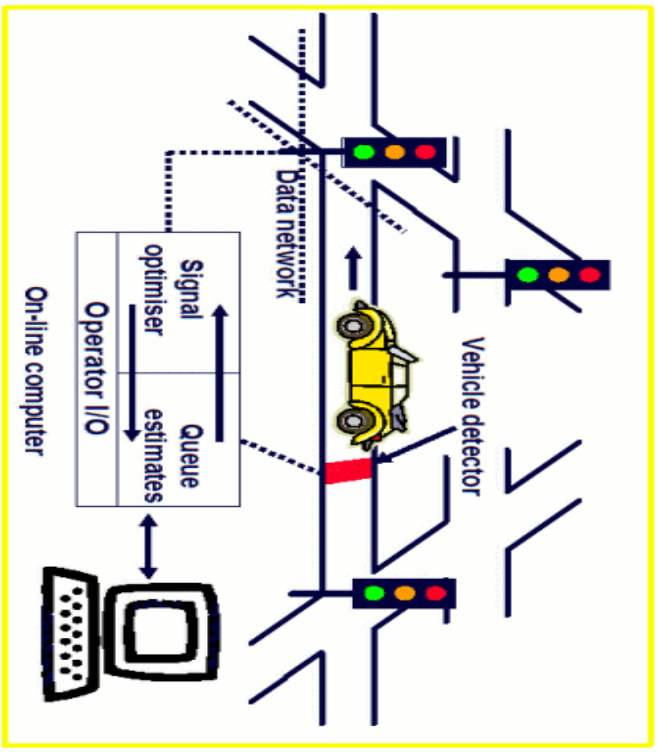
PLC System


Power supply
Central processing unit (CPU)
Memory
program
data
Input module
Output module
Input sensing devices
Output load devices
M
Programming device

PLC Applications

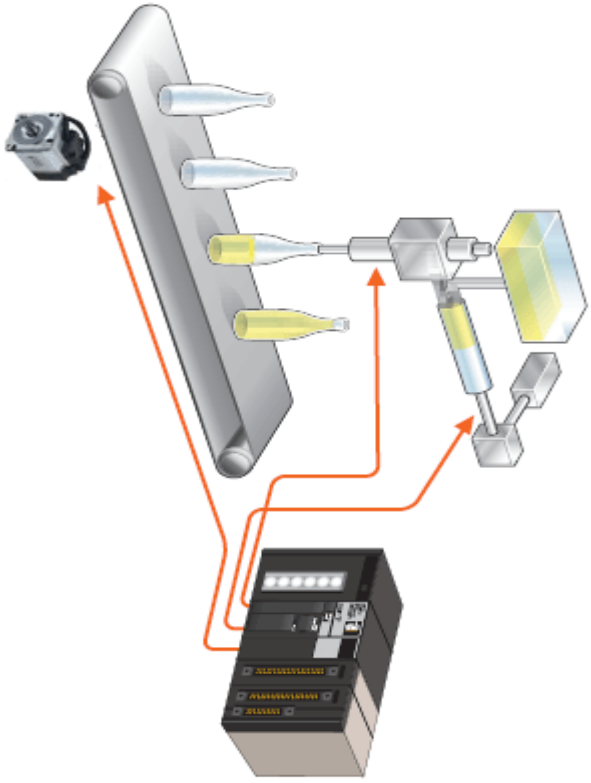
The common applications of PLCs:

- Production lines
- Elevators
- Escalators
- Traffic Control
- Robot:
  - Toxic chemical materials spraying robot
  - Skyscrapers glass washing robot

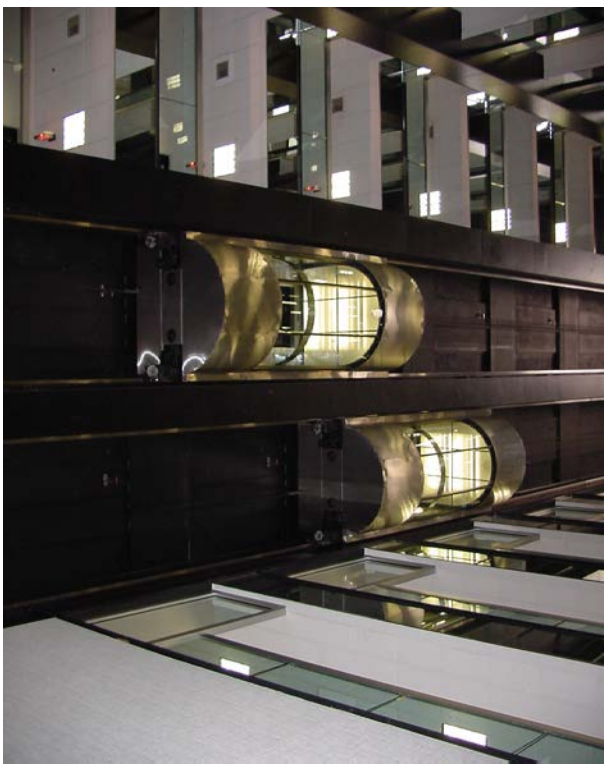


Traffic Control

Escalator

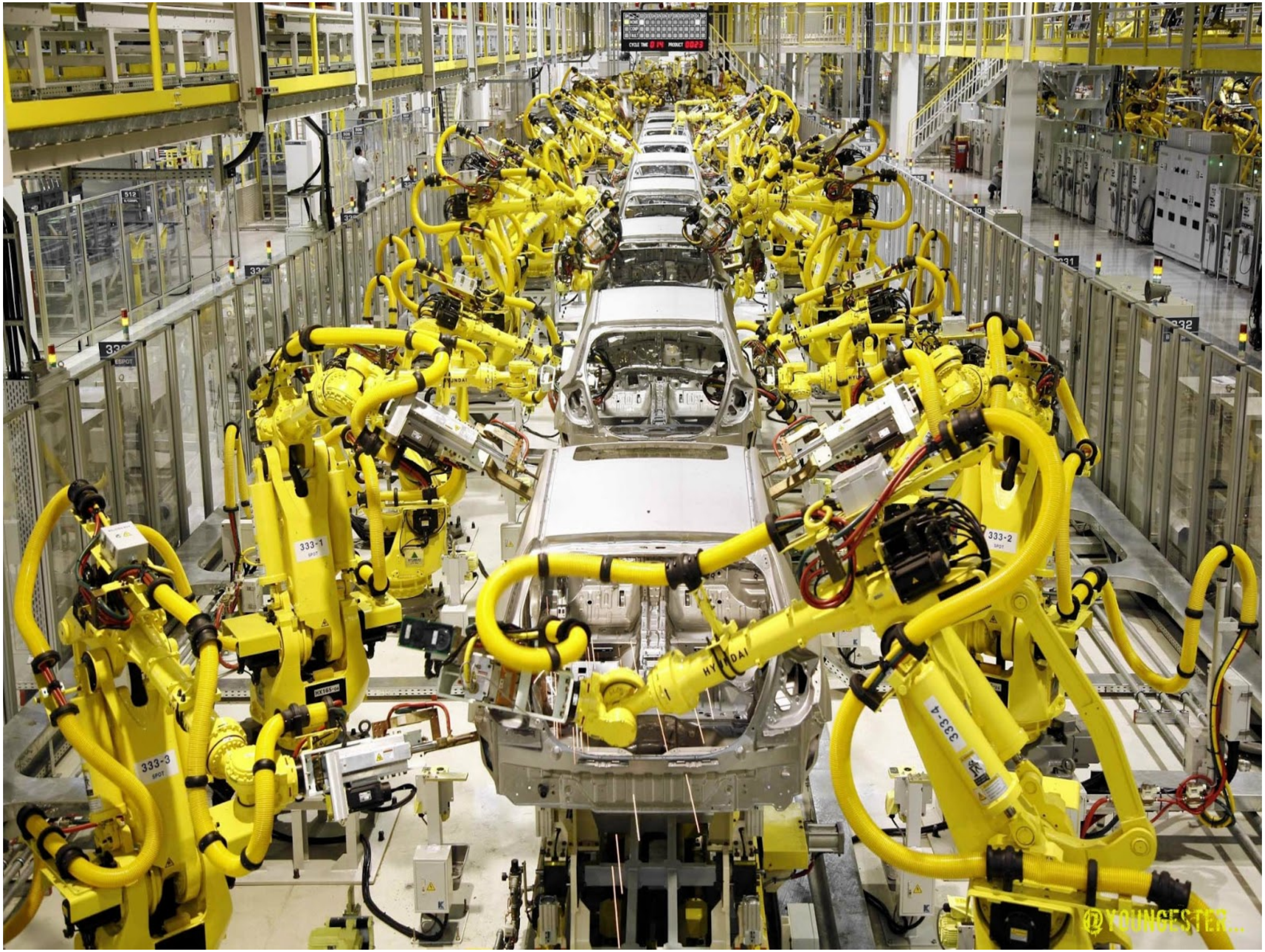


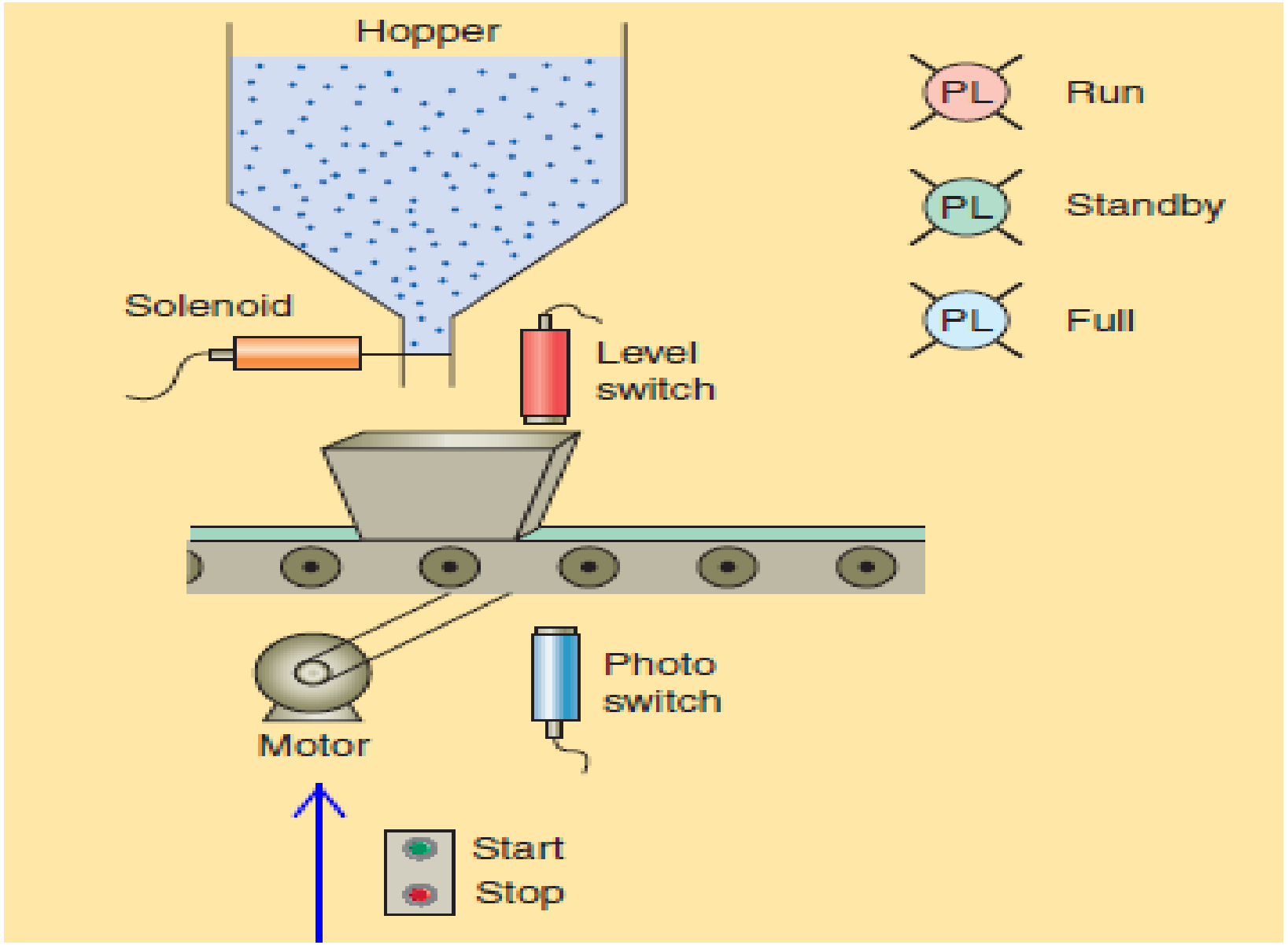
Production Line



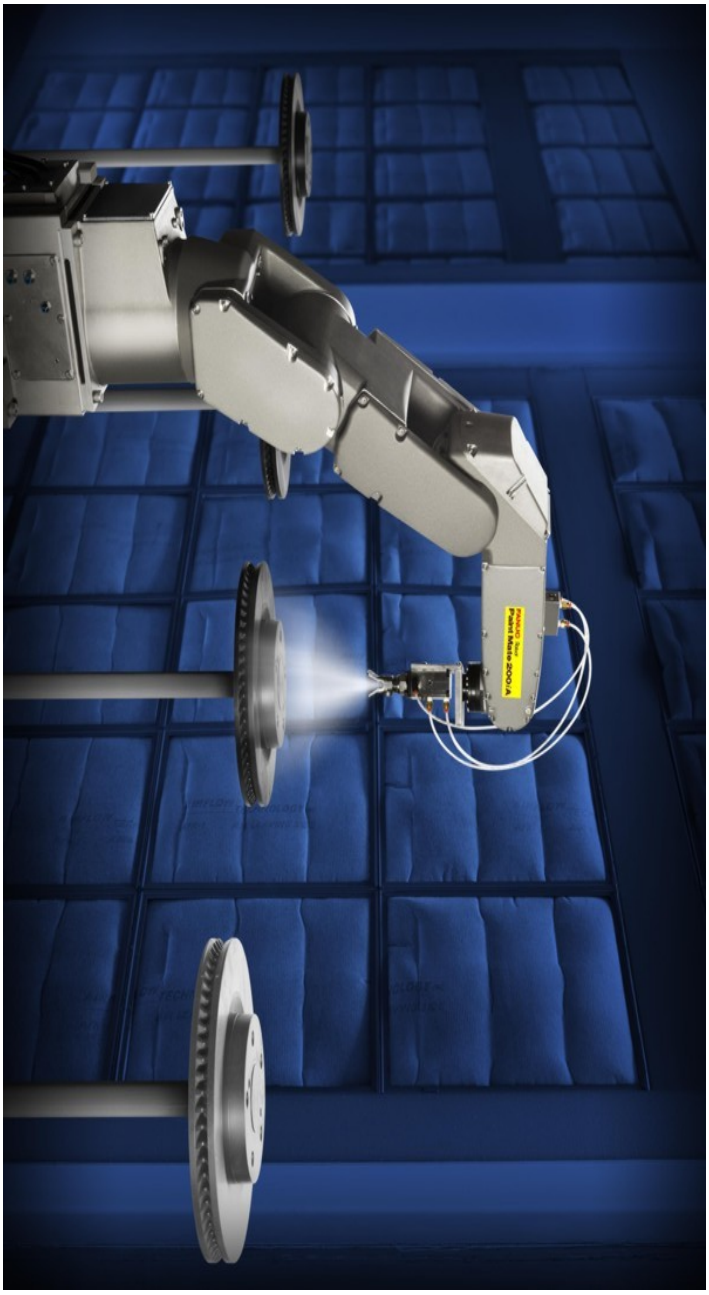
Elevator

Production Line





Production Line



Washing Robot

Spraying Robot

Common PLC's Manufacturers

- Siemens
- ABB
- Schneider (Modicon)
- Rockwell (Allen-Bradley)
- Mitsubishi
- Omron
- LG
- Toshiba

Mitsubishi

Schneider

Siemens

LG

Allen-Bradley

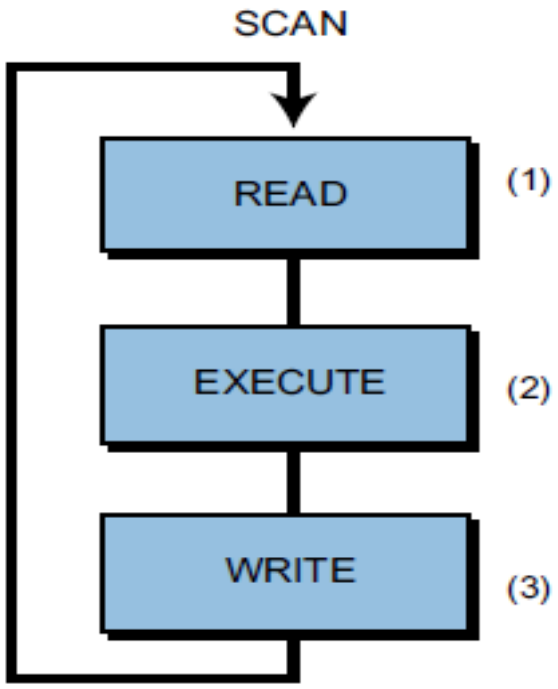
ABB

How Can I Choose A PLC?

- Will the system be powered by AC or DC voltage?
- Does the PLC have enough memory to run my user program?
- Does the system run fast enough to meet my application's requirements?
- What type of software is used to program the PLC?
- Will the PLC be able to manage the number of inputs and outputs that my application requires?
- How am I going to communicate with my PLC?
- Do I need network connectivity and can it be added to my PLC?

How Does A PLC Operate?

- During the PLC operation, the CPU completes three sequential processes: **Read** (Input Scan), **Execute** (Program Scan), and **Write** (Output Scan)



How Does A PLC Operate?

- **(1) Read:**

  Detects the state of all input devices that are connected to the PLC

- **(2) Execute:**

  Executes the user control program stored in the memory

- **(3) Write:**

  Updates (energizes or de-energize) all output devices that are connected to the PLC.

- This process of sequentially reading the inputs, executing the program in memory, and updating the outputs is known as **scanning.**

PLC Programming Languages

There are four programming languages that are used to program a PLC:

a. Ladder Diagram (LD)

b. Function Block Diagram (FBD)

c. Structured Text (ST)

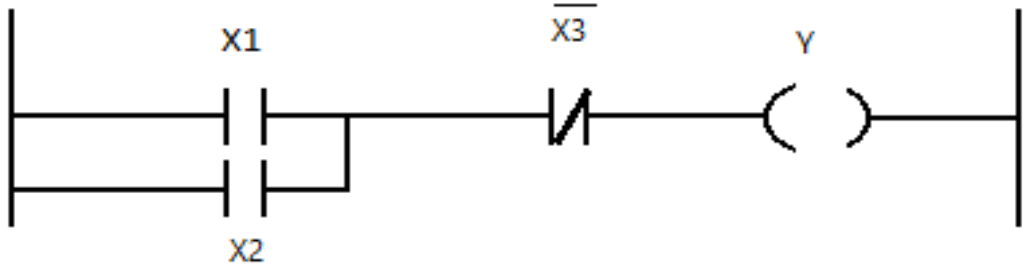
d. Instruction List (IL)

Ladder diagram is the most commonly used PLC programming language

PLC Programming Languages

a. Ladder Diagram (LD)

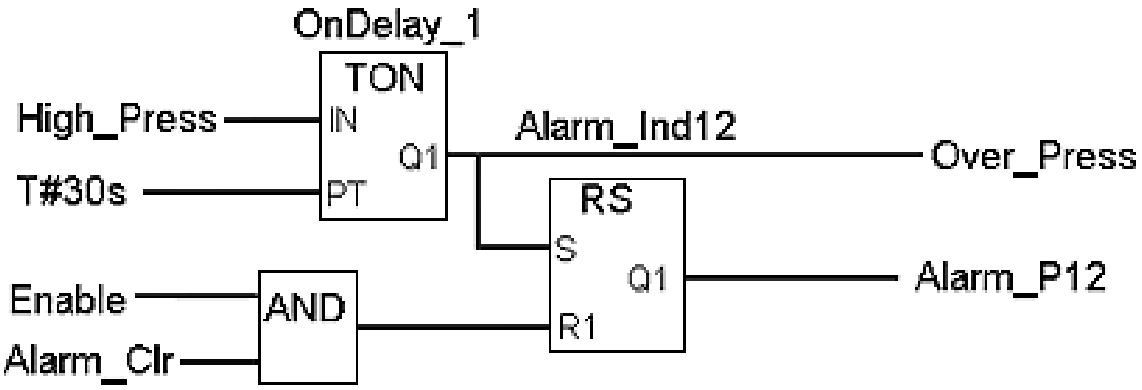
A graphical programming language. Initially programmed with simple contacts that simulated the opening and closing of switches and relays, Ladder Logic programming has been expanded to include such functions as counters, timers, shift registers, and math operations.



PLC Programming Languages

b. Function Block Diagram (FBD)

A graphical programming language for describing signal and data flows through re-usable function blocks. FBD is very useful for expressing the interconnection of control system algorithms and lo



PLC Programming Languages

c. Structured Text (ST)

A high level text language that supports structured programming. It has a language structure (syntax) and supports a wide range of standard functions and operators.

```
If Speed1 > 100.0 then
   Flow_Rate: = 50.0 + Offset_A1;
Else
   Flow_Rate: = 100.0; Steam: = ON
End_If;
```

PLC Programming Languages

d. Instruction List (IL)

A low level language “like **assembly** language” that is based on similar instructions list languages found in a wide range of today’s PLCs.

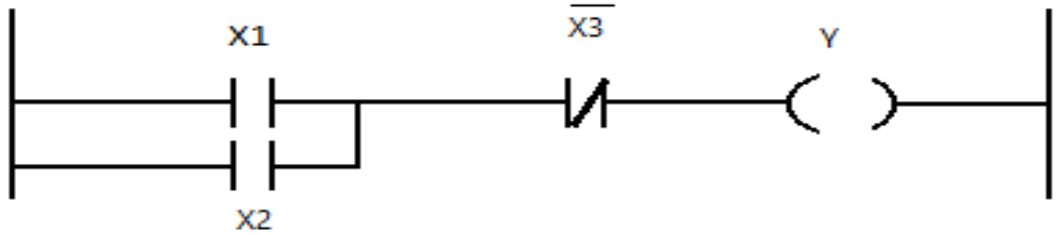
Instruction		Description
LD	:	load input
LDI	:	load inverse input
OR	:	or wit = branching = parallel
ORI	:	or inverse with
AND	:	and with = series
ANI	:	and inverse with
OUT	:	out to

PLC Programming Languages

d. Instruction List (IL)

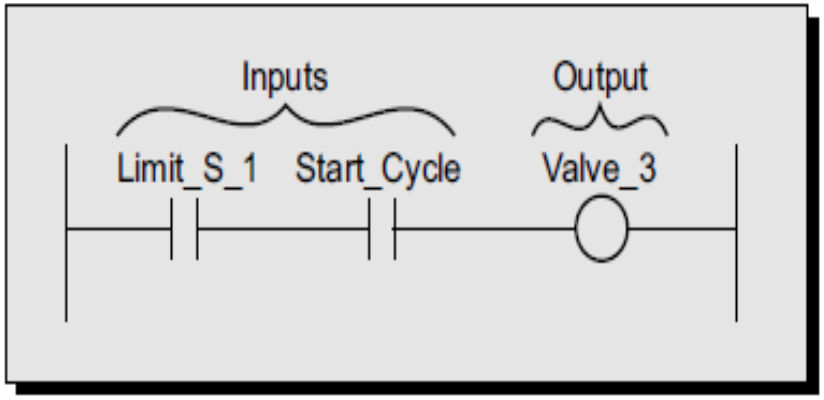
LD	X1
OR	X2
ANI	X3
OUT	Y

Instruction List

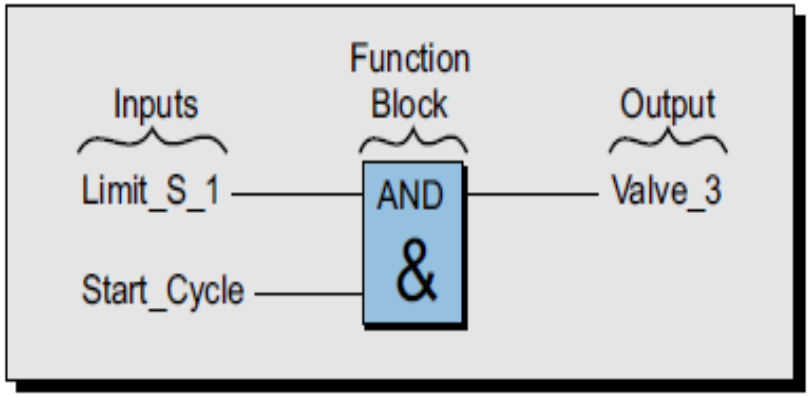


Ladder diagram

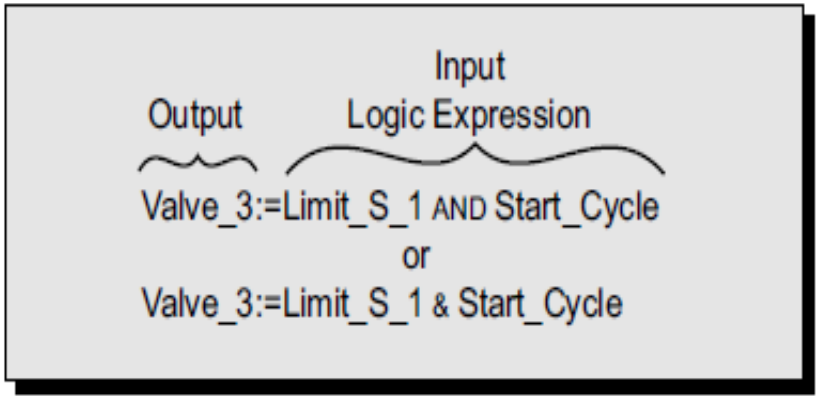
Example: A PLC program using different Programming Languages



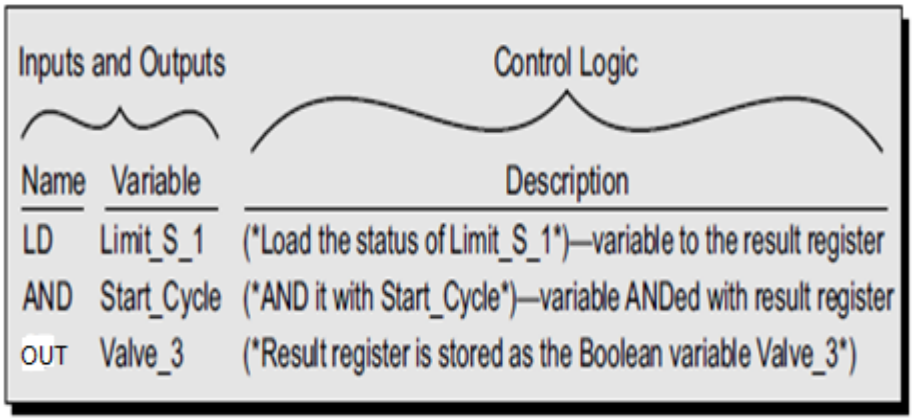
(a) Ladder diagram (LD)



(b) Function block diagram (FBD)



(c) Structured text (ST)



(d) Instruction list (IL)

Reference Books:

1) " Programmable Controllers - Theory and Implementation", L.A. Bryan and E.A. Bryan.
2) " Programmable Logic Controllers – Principles and Applications", John Weeb.